Claims

What is claimed is:

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1. A heat transfer apparatus for use in measuring a rheological property of a test sample, the heat transfer apparatus comprising:

a receptacle for receiving the test sample; and

a heat conveying member in heat transfer relation to the receptacle, the heat conveying member defining at least two internal passages extending substantially equidistant from one another through at least a portion of the heat conveying member to provide for counter-flowing circulation of a fluid.

2. The heat transfer apparatus according to claim 1 wherein the heat conveying member comprises an inlet and an outlet and a passage splitter adjacent the inlet for dividing a single passage into separate passages, the heat conveying member further comprising a passage union adjacent the outlet for linking separate passages into a single passage.

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3. The heat transfer apparatus according to claim 2 wherein the heat conveying member comprises a plurality of heat sinks interconnected to form an assembly of heat sinks.

4. The heat transfer apparatus according to claim 3 wherein each of the heat sinks define internal passages and wherein the heat transfer apparatus comprises a plurality of tubular members each extending between adjoining heat sinks and having a first end contacting an internal passage of one of the adjoining heat sinks and an opposite second end contacting an internal passage in the other of the adjoining heat sinks.

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5. The heat transfer apparatus according to claim 3 wherein a first passage in one of the heat sinks is located inwardly from a second passage with respect to the assembly of heat sinks.

6. The heat transfer apparatus according to claim 1 wherein the heat conveying member is part of a hybrid heat transfer system in which the heat transfer apparatus further comprises at least one heat exchanging element in heat transfer relation to the receptacle to transfer heat to and from the receptacle, the heat conveying member being in heat transfer relation to the heat exchanging element for transferring heat to or from the heat exchanging element.

7. The heat transfer apparatus according to claim 6 wherein the heat exchanging element comprises a thermoelectric module, the module responsive to electric current to establish transfer of heat through the module from a first side of the module to an opposite second side of the module.

8. The heat transfer apparatus according to claim 7 wherein the thermoelectric module comprises a multi-stage thermoelectric module.

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9. A cold cranking simulator comprising:

a receptacle for receiving a sample of oil;

at least one heat exchanging element in heat transfer relation to the receptacle, the heat exchanging element responsive to electric current for transferring heat to or from the receptacle; and

a heat conveying member in heat transfer relation to the heat exchanging element for transferring heat to or from the heat exchanging element, the heat conveying member defining at least two internal passages extending

substantially equidistant from one another through at least a portion of the heat conveying member to provide for counter-flowing circulation of a fluid.

10. The cold cranking simulator according to claim 9 wherein the heat conveying member comprises an inlet and an outlet and a passage splitter adjacent the inlet for dividing a single passage into separate passages, the heat conveying member further comprising a passage union adjacent the outlet for linking separate passages into a single passage.

11. The cold cranking simulator according to claim 10 wherein the heat conveying member comprises a plurality of heat sinks interconnected to form an assembly of heat sinks.

12. The cold cranking simulator according to claim 11 wherein each of the heat sinks define internal passages and wherein the heat transfer apparatus comprises a plurality of tubular members each extending between adjoining heat sinks and having a first end contacting an internal passage of one of the adjoining heat sinks and an opposite second end contacting an internal passage in the other of the adjoining heat sinks.

13. The cold cranking simulator according to claim 11 wherein a first passage in one of the heat sinks is located inwardly from a second passage with respect to the assembly of heat sinks.

14. The cold cranking simulator according to claim 9 further comprising a temperature control system having a temperature probe for generating a signal representing a temperature monitored by the probe, the control system

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controlling the current for the heat exchanging element in response to the signal generated by the probe.

15. A method of controlling the temperature of a rheological test sample, the method comprising the steps of:

providing a rheological test cell having a receptacle for receiving the rheological test sample and a heat exchanging element responsive to electric current in heat transfer proximity to the receptacle for transfer of heat to or from the receptacle, the test cell further having a heat conveying member in heat transfer relation to the heat exchanging element for transferring heat to and from the heat exchanging element, the heat conveying member defining at least two internal passages extending substantially equidistant from one another through at least a portion of the heat conveying member;

positioning a temperature sensor in monitoring proximity to the receptacle;

introducing the rheological test sample into the receptacle;

measuring the temperature of the receptacle with the sensor;

controlling the electric current supplied to the heat exchanging element in response to the measured temperature of the receptacle to vary the transfer of heat to or from the receptacle for maintaining the receptacle substantially at a desired temperature:

circulating a fluid from a fluid source in the internal passages for transferring heat to or from the heat conveying member by channeling a portion of fluid in a first one of the passages in a direction which is opposite from that of a portion of fluid in a second one of the passages to limit temperature gradients across the receptacle.

16. The method according to claim 15 wherein the heat conveying member comprises an inlet and an outlet and a passage splitter adjacent the inlet for dividing a single passage into separate passages, the heat conveying member further comprising a passage union adjacent the outlet for linking separate passages into a single passage.

17. The method according to claim 15 wherein the heat exchanging element comprises a thermoelectric module, the module responsive to electric current to establish transfer of heat through the module from a first side of the module to an opposite second side of the module and wherein the step of controlling the electric current includes the step of reversing the direction of the electric current to establish transfer of heat through the module from the second side of the module to the first side.

18. The method according to claim 17 wherein the thermoelectric module comprises a multi-stage thermoelectric module.

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